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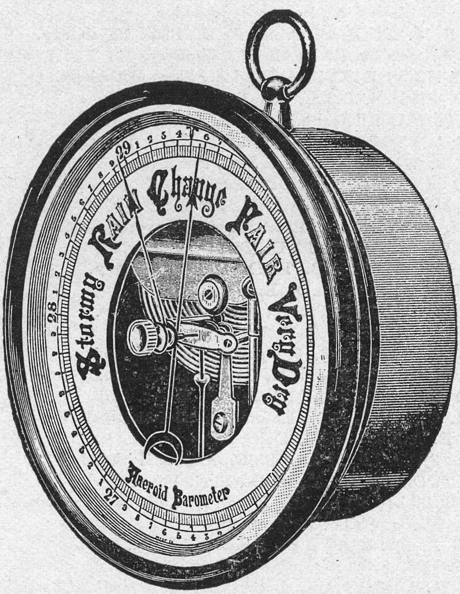
CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF

THE COLLEGE OF AGRICULTURE

Department of Meteorology

FROSTS IN NEW YORK



Aneroid barometer. A good serviceable instrument may be purchased for $10 to $15, depending on the size and finish

By WILFORD M. WILSON

ITHACA, N. Y.
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FROSTS IN NEW YORK

Wilford M. Wilson

Local topography, particularly with reference to elevation, slope, and proximity to large bodies of water, exerts so marked an influence on the climate of a place that in such a State as New York, with its mountains, valleys, lakes, and plateaus, any generalizations of climatic conditions that would be of value to the practical farmer become extremely difficult, if not impossible. In some respect nearly every locality enjoys a climate of its own. This is true with regard to frosts in particular, for local topography undoubtedly influences the occurrence of frost to a greater degree than it does any other climatic element. The average temperature or rainfall of a place may be approximated very closely from the average temperature or rainfall of places some distance away; but where there is an appreciable variation in the topography, the frost records of one place cannot be regarded as an absolute guide for the frost conditions of another, although the distance between the places may be only a few miles. Every farmer has learned by experience that frost liability varies for even so small an area as his own farm. For this reason, it has been considered advisable to present the frost records for New York in much greater detail than has been attempted heretofore.

Records of frost for several places in nearly every county are given in the tables at the end of the bulletin. If accepted with due regard to local topography (the effect of which will be pointed out in some detail further on) and in the light of practical experience, these records should enable the farmer to approximate very closely the frost liability of his own locality. No means has yet been devised that can be employed economically by the general farmer to protect large areas from frost; nevertheless, the sort of knowledge derived from the records has a distinct value, which lies in the fact that it makes possible the adjustment of the crop scheme to accord with the requirements of the climate. The frost liability of a place cannot be changed, because it is based on climate and climate does not change; but with a knowledge of the climate in respect to frost, varieties suitable to the locality may be selected and the time of planting and harvesting so regulated as to avoid risk of injury by frost, or at least to reduce the necessary risk to a minimum.

MEANING OF THE TERM FROST

Frost is defined commonly as the moisture of the air condensed at freezing temperatures on plants or other objects near the surface of the

earth. It is obvious, therefore, that the temperature of the surface on which frost forms must be at or below the freezing point. Since ice forms at a temperature of 32° F. and it is the formation of ice in the intercellular spaces of a plant that results in injury, the temperature of the plant thus becomes the determining factor, and not the appearance of any deposit of frost on its surface. When frost forms on a plant, it is good evidence, of course, that the exterior of the plant is at or below the freezing point of water; but if the temperature at which condensation of moisture in the air takes place is below freezing, as is frequently the case, ice may form in the intercellular spaces of the plant and destroy it without any deposit of frost appearing on its surface. For this reason, the term " frost " as used in this bulletin is to be understood as signifying injurious temperatures without regard to any deposit of ice that may or may not have appeared on the exterior of plants or other objects.

HOW OBSERVATIONS OF FROST ARE MADE

It is the practice of observers connected with the United States Weather Bureau to record three degrees of frost — light, heavy, and killing. A light frost is recorded when only the tenderest plants are injured; a heavy frost, when the injury is more marked and the hardier plants are damaged; and a killing frost, when the staple products of the region are injured severely or are killed. When no deposit of frost occurs and the temperature of the air as indicated by the thermometer falls during the night to 32° F., a killing frost is recorded also. The charts and tables presented herewith are based on records of killing frosts only.

The records of frosts made at the regular Weather Bureau stations in the State — New York City, Albany, Canton, Syracuse, Oswego, Rochester, Buffalo, Ithaca, and Binghamton — represent to a considerable degree the conditions with respect to frost that obtain in those cities.

FROSTS IN CITY AND COUNTRY

It is well known that the air over cities, particularly on clear nights when frost is likely to occur, almost invariably is warmer than the air over the open country. A comparison of the minimum night temperatures in the city of St. Louis, Mo., with those at Forest Park, a suburb of St. Louis, for a period of five years shows that the air at night over the city averaged 4.6° warmer than that over the suburb. For the month of September the average difference at night was 9°. A similar comparison of observations made since 1882 at the United States Weather Bureau station in the city of Columbus, Ohio, and on the campus of Ohio State University, three miles distant, shows that the air six feet above ground at the university is 3.3° colder at night than that

over the city. Comparison of country and city temperatures at many other places gives essentially the same results.

The higher night temperatures of cities are attributed mainly to the heat given off from buildings and pavements, and to the effect of smoke from the many city fires, which collects over cities on quiet nights and, by retarding the escape of heat from the surface, tends to hold the air at

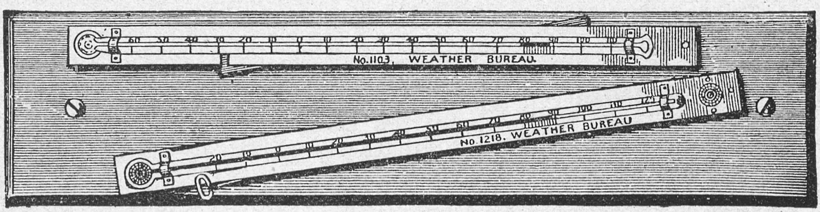

FIG. 135.—*Maximum and minimum thermometers (Weather Bureau pattern). Price, mounted as shown, about $8*

a higher temperature than would obtain otherwise. For this reason, records of frost made in large cities cannot be regarded as a reliable guide to the occurrence of frost in the open country; and, while the records of frosts made in the cities of the State have been retained in the tables, they have been disregarded, for the most part, in making up the accompanying charts.

FROST IN THE OPEN COUNTRY

The observations of frost and the temperatures recorded by cooperative observers of the Weather Bureau — who, in the main, are located in the open country or in small villages — may be considered as representing very closely the conditions that obtain on the farm.

The instruments used by cooperative observers are carefully standardized and their exposure is as nearly uniform as possible. The thermometers — a maximum registering the highest temperature in each twenty-four hours, and a minimum registering the lowest — are exposed in shelters of standard construction so that the results are strictly comparable. Generally, the thermometers are placed about four feet above ground, and their readings indicate the temperature of the air at that elevation.

The practice of recording a killing frost when the air temperature at a height of four feet above ground falls during the night to 32° has been objected to on the ground that it does not represent the temperature of the air in contact with plants at the surface. This is true, but it may be pointed out also that the temperature of the air in contact with the plants does not represent the temperature within the inter-

cellular spaces, where injury from freezing occurs. Moreover, plants differ greatly in their ability to withstand cold, and a temperature that will destroy at one stage of the plant's development may cause little or no injury at another stage. Again, injury may depend on other conditions. If the water that is abstracted from the cells by the process of freezing and that congeals in the intercellular spaces is again returned to the cells—that is, reabsorbed—as is sometimes the case, there will be little or no injury to the plant. This occurs when the process of thawing takes place very slowly. A cloudy morning or a cold rain after a frost is often the means of saving a crop by retarding the thawing process. From the foregoing, it will be seen that it is very difficult, if not impossible, to select a critical or injurious temperature that will apply in all cases; and it is even more difficult to choose a place where such a temperature may be obtained.

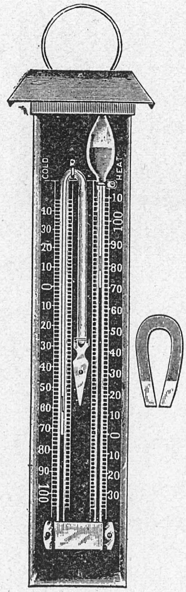

FIG. 136.—*Six's pattern maximum and minimum thermometer. This instrument gives the highest and the lowest temperature for each day, also the current temperature at any time. It is a very excellent thermometer for farm use. Price, $2 to $5*

It is a common experience that vegetation at the surface is sometimes killed when the temperature of the air four feet above the surface remains above freezing; but rarely is there an absence of frost or of injurious temperature when the air temperature four feet above the surface falls to 32°. This is due to the fact that on clear, quiet nights when frost is likely to occur, the air at the surface is nearly always colder than it is a few feet above the surface. This difference may amount to as much as 10°, or even 15°, in as many feet, but usually it is much less. The difference is greater on clear nights than on cloudy nights, for clouds act as a blanket and retard the escape of heat from the earth, thus tending to maintain the whole stratum of air between the earth and the clouds at a higher temperature than if no clouds were present. The difference is greater also on quiet nights, for winds mix the air, preventing the colder, heavier air from settling to the ground and thus maintaining the temperature more uniform. Hence, since the temperature at night usually increases from the surface upward to a certain limit, which is above the height attained by ordinary vegetation, it is obvious that freezing temperatures may occur at the surface when the air temperature four feet above is considerably above freezing, but rarely, if ever, will vegetation at the surface escape injury when the temperature at a height of four feet falls to 32°.

Moreover, the records of cooperative observers are made mostly from instruments located in shelters designed to screen the thermometers from the direct rays of the sun; but such shelters act also as a hindrance to radiation of heat, particularly on clear, quiet nights, so that shelter temperatures are somewhat higher on such nights than open-air temperatures. Professor Cox found that the average temperature of the air at night inside a shelter five inches above ground was about 3° higher than the outside air temperature at the same elevation. Therefore, it would seem that the practice of recording a killing frost when the temperature in the shelter at the height of the thermometers falls to the freezing point is justified.

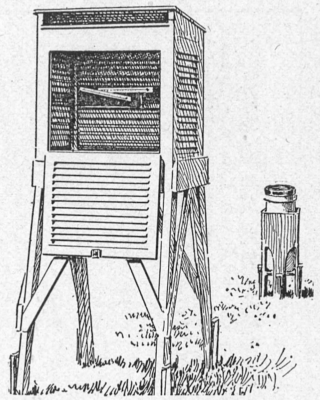

FIG. 137.—*Thermometer shelter and rain gauge for cooperative observers*

In this connection it may be pointed out that for tree fruits this practice cannot be justified on these grounds. In tree fruits the blossom is the point where injury occurs, and the blossom usually is more than four feet above ground. Since on frosty nights the temperature increases with the elevation, a freezing temperature at the height of the thermometers may not mean a critical temperature at the height of the blossom. In considering the accompanying frost data from the viewpoint of fruit culture, some allowance should be made for difference in temperature due to difference in elevation. Just how much allowance should be made in individual cases depends on the condition of the sky, the soil, and the wind; but when the sky is clear and there is little air movement, a shelter temperature of 30° should be considered critical at a height of ten to fifteen feet above the ground.

EFFECT OF LARGE BODIES OF WATER ON FROST

Under similiar conditions land warms and cools about five times as rapidly as does water. For this reason, the air over large bodies of water usually is cooler in the daytime and warmer at night than the air over adjacent lands. During the winter months the temperature of the water is lowered to such a point that seas and lakes remain comparatively cool throughout the spring and exert a twofold influence on the air temperature for a considerable distance inland: (1) the cold air from above the water tends to retard vegetation until the period of spring frosts has passed; (2) since the air over the water partakes of its temperature, which

is considerably above the freezing point during the period of spring frosts, it tends to hold the temperature of the air over adjacent lands, particularly at night, above the point of danger. In the fall the water gives off the large quantities of heat stored up during the warm summer months and thus wards off frosts.

For these reasons, a location near a large body of water enjoys an immunity from frost not found in inland localities. Reference to the accompanying charts of the last killing frost in spring and the first in fall

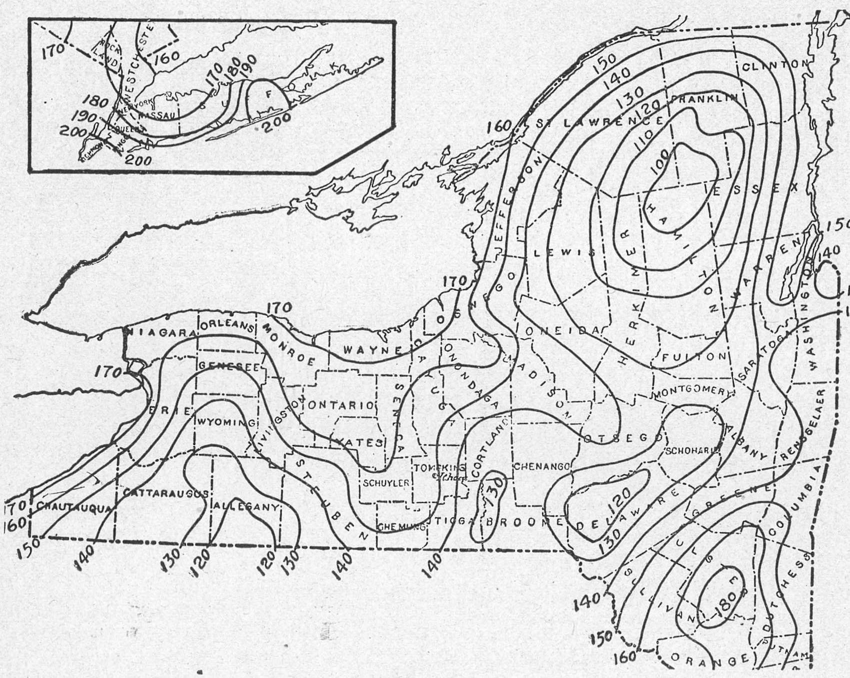

FIG. 138.—*Average number of days between the last frost in spring and the first in fall*

will make this clear. In New York the prevailing winds are from a westerly direction, and for this reason the east side of a body of water is considered most favorable so far as freedom from frosts is concerned. The influence of a body of water also extends farthest on its east side, the distance depending mainly on the size of the body of water and on the slope of the land. The distance is greater for large bodies of water and for land that slopes gently away from the water. For example, the south shore of Lake Erie in New York rises abruptly from the water and the influence of the lake is appreciable for a distance of only a few miles inland; while the influence of Lake Michigan, because of the gentle slope

of its eastern shore, extends in some places probably halfway across the State of Michigan.

EFFECT OF ELEVATION ON FROST FREQUENCY

Every farmer knows that frost is less likely to occur at moderate elevations or on low hills than in low places, and what has been said regarding the increase in temperature at night from the surface upward might seem to afford a sufficient explanation of this fact. However, there are several causes that operate to give elevated lands a greater immunity from frost than adjacent valleys enjoy. A valley usually is shaded for a longer period, both in the morning and in the evening, than are the uplands, and therefore it goes into the night with a smaller store of heat with which to combat the frost. This, however, does not explain the immunity from frost on hillsides that face away from the sun for a large part of the day, which brings us to the consideration of the principle of air drainage.

The cooling of the air at night begins at the surface, and when the layer of air in contact with the surface becomes cooler than the air about it, it also becomes heavier and begins to slide down the slopes for the same reason that water runs down hill. Hence, the cold air accumulates in the valleys. When it leaves the hilltops its place is taken by warmer air, which in turn is cooled by contact with the cold surface and, becoming heavier, starts on its journey to the valley. Thus, a gentle circulation is maintained throughout the night. Again, the stronger winds usually present on plateaus and hills tend to maintain a more uniform temperature by mixing the air and preventing its colder parts from settling to the surface.

There are many striking examples of the effect of this draining of cold air away from the hills and its accumulation in the valleys. F. W. Stow, of the Royal Meteorological Society, mentions an instance of this character, which shows how remarkably clear-cut the line between frost and no frost sometimes is:

> At the end of May, 1894, there was a frost in the interior of England. After the frost, the ash trees in the valley bottoms were completely frost-bitten; those that grew somewhat higher up on the slopes were frost-bitten below their crowns, but the crowns were green; those that grew on still higher ground had their lower halves frozen, but the upper halves were green; while the ashes growing on the hills surrounding the valley were not injured in the slightest degree.

Professor Howard, Secretary of the Missouri State Board of Horticulture, calls attention to the fact that certain sections in that State nearly always escape injury from spring frosts. He instances the famous

peach region about the town of Koshkonong, in Oregon county. George Reeder, of the United States Weather Bureau, after a careful study of the topography and climatic conditions, reaches the conclusion that the immunity of the orchards in that vicinity from frost results from drainage of the cold air away from the orchards, and, although the slope of the land is slight, it is sufficient to ward off frost.

The famous regions known variously as "thermal belts," "frostless zones," or "verdant zones," found in certain mountainous districts of North Carolina and elsewhere, result from air drainage. The verdant

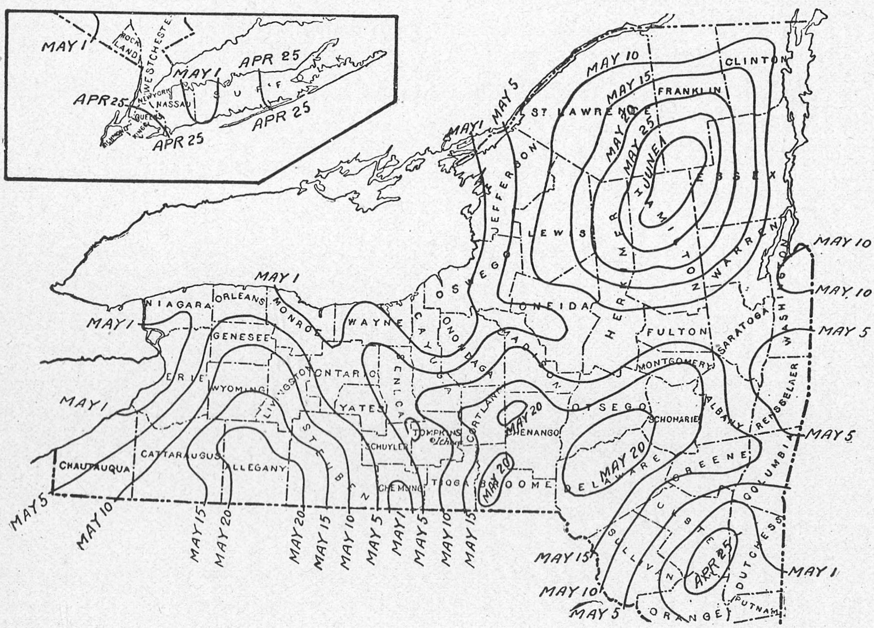

FIG. 139.—*Average date of last killing frost in spring*

zone in Macon county, North Carolina, in the valley of the Little Tennessee River, was described by Silas McDowell in 1861. It lies between 300 and 700 feet above the valley floor, and the valley floor is about 2,000 feet above sea level. The breadth of this zone is about 400 feet. It follows up the smaller tributaries of the river, and in the higher valleys, where the valley floor is 3,900 feet above sea level, the verdant zone lies between 4,000 and 4,100 feet. It is said that within this zone frost never injures vegetation and the tenderest grapes never fail to produce abundant crops. A similiar zone is found in Polk county, North Carolina, on the flank of the mountain spur adjacent to the valleys of the Blue Ridge.

This phenomenon is easily explained; it is due mainly to the fact that the outlet and slope of the valley are not sufficient to carry off, as rapidly as it accumulates, the cold air that slides down the mountain sides. Thus, the depth of the cold air in the valley increases as the night goes on, for the same reason that water rises in and fills a valley when a dam is thrown across its outlet. Now the warmer air, being lighter, floats on the surface of the colder air that fills the valley, and, coming in contact with the surface of the mountain sides, yields up its heat to the vegetation and thus gives immunity from frost. The upper limit of the verdant zone probably depends on the strength of the wind and the general temperature of the free air.

The effect of air drainage on frost conditions is often quite as marked where the differences in elevation are much less than in the foregoing examples. The so-called frost island, discovered by Winchell in the southeastern part of Michigan, is really the bottom of a depression into which the cold air settles. The surrounding elevated lands are much freer from frost, though the difference in elevation is small.

The lesson to be learned from these facts is that tender crops which are liable to injury by frost should not be planted on low lands, particularly when there is no outlet through which the cold air may drain away. A low hill or a gently sloping hillside somewhat above the valley floor is to be preferred as a location for an orchard or a garden. Just how high one should go on the hillside can be determined usually by careful observation of frosts for a single season. So much depends on the lay of the land and the grade of the slope that no rule can be given which will apply in all cases. With due regard to the foregoing principles of air drainage, experience and careful observation are the best guides.

EXPOSURE

In the latitude of New York State, hillsides exposed toward the south are warmest; next come those facing east, then west, and finally north. Liability to frost follows in the reverse order, being greatest on the north side. It is pointed out, however, that the fact that frost is less likely to occur with a southern exposure is not sufficient reason of itself for choosing the south side as a location site for an orchard, for the higher temperature on that side brings the blossoms out at an earlier date than on the north side; hence, a frost may kill the crop on a southern slope before the buds on a northern slope are in condition to be injured. On the other hand, the argument is advanced that when the trees on both sides are in bloom, the greater amount of heat stored in the soil on the warmer side may be sufficient to ward off a frost that would kill the crop on the colder side. There are numerous observations to show the temperature of the air and soil

for the different exposures, but there are none known to the writer that tend to show the comparative value of the various exposures with respect to injury from frost when the difference in date of blooming is considered.

It appears that a majority of fruit growers in this State consider the northern exposure preferable, believing that the retarding of the date of blooming, due to the lower temperatures of the northern slope, more than compensates for the greater freedom from frost on the southern slope.

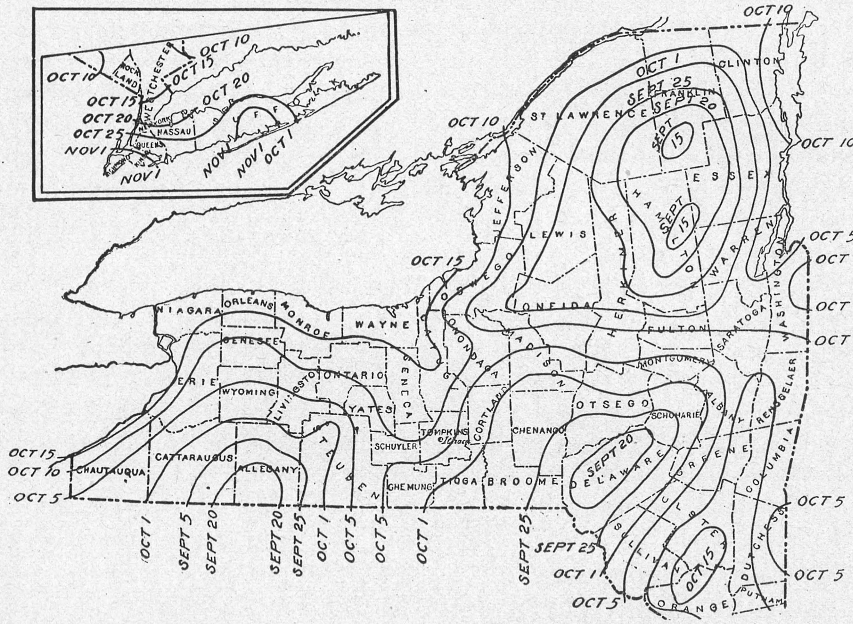

FIG. 140.—*Average date of first killing frost in fall*

EFFECT OF SOIL AND SOIL COVERING ON FROST

In investigating the conditions under which frost occurred in the cranberry districts of Wisconsin, the writer found that old cranberry bogs covered with a thick carpet of dried vines were much more liable to frost than were bogs more recently planted. It was believed that the thick covering of vines prevented a large part of the heat received from the sun during the daytime from reaching the soil, and, since but little heat was stored up by day, only feeble resistance was offered to the fall of temperature at night.

In the Cape Cod cranberry marshes it is the practice to spread about half an inch of sand over the surface of the marshes each year, thus cover-

ing the dry vines and furnishing a reservoir for the storage of heat received by day against the low temperatures at night.

Professor Cox made a series of observations on the temperature of the air over peat and sanded bogs five inches above the surface at Cranmoor, Mather, and Berlin, Wis., of which he says:

For two months the (night) temperature over the sanded bog averaged higher than over the peat bog, as follows: Cranmoor, 5.3°, Mather, 4.4°, and Berlin, 5.4°; the greatest daily difference was 11° at Cranmoor on August 30 and at Mather on September 15, and 19° at Berlin on August 11. At no time did the minimum temperature over peat register higher than over sand at any one of the three stations. There were several dates, however, when there was no difference in the readings of the instruments over the peat and over the sand. This occurred invariably on cloudy nights when the temperature was high and there was no danger from frost.

Dewey A. Seeley, in investigating the effect of surface covering on temperature at Peoria, Ill., exposed four minimum thermometers as follows: No. 1, about half an inch below the surface of bare ground; No. 2, on the surface of bare ground; No. 3, half an inch below the surface of sod; No. 4, on the surface of sod. The four instruments were read on eighteen mornings after clear, quiet nights, also on thirteen afternoons when the weather was clear and the wind light. The results obtained were as follows:

	Average temperatures	
	Morning	Afternoon
No. 1, half inch below bare ground	30.1°	46.2°
No. 2, on surface of bare ground	27.3	45.0
No. 3, half inch below sod	36.2	47.9
No. 4, on surface of sod	23.9	43.0

Mr. Seeley calls attention to the fact that, although the soil under sod was warmest at night, its surface was coldest, the difference being surprisingly large, 12.3°, within the distance of about one inch between the two thermometers. This seems to indicate that comparatively little heat escapes through the sod covering at night, and that the loss of heat from the surface of the sod is very great. It is pointed out also that the temperature over sod was 3.4° below the temperature recorded over bare ground, indicating that the heat given off by the bare ground during the night was effective in raising the temperature of the air in contact with

the surface. Mr. Seeley also found that the temperature of the air over soil that had been tilled recently averaged about 2° higher than that over similar soil that had not been cultivated for some time, and suggests the advisability of thorough tillage as a measure tending to protect against the effect of frost.

Professor Cox found that poorly drained cranberry bogs were much more liable to frost than those that were well drained, the average night temperature over poorly drained soils being 2.4° below that over the drier soils. In one instance the lack of proper drainage resulted in a total loss of the crop in the wet sections of the marsh, where the temperature fell to 27.3°; while in the drier sections the berries were unharmed, the lowest temperature being 35.8°. The relatively low temperatures over wet soils undoubtedly are due to excessive evaporation during the daytime, which uses up heat that over drier ground would go to raise the temperature of the soil, so that when night comes there is little heat in the soil to resist the fall in temperature.

The foregoing facts seem to show very clearly that the farmer who gives attention to proper cultivation and drainage will obtain not only the advantage of larger yields, but a certain immunity from frost as well.

FROST WARNINGS ISSUED BY THE UNITED STATES WEATHER BUREAU

It is entirely possible to forecast the occurrence of frost with a reasonable degree of accuracy twelve to twenty-four hours in advance. It is possible, also, to protect from frost to a limited degree. Nevertheless, so far as the general farmer is concerned, unless he is prepared to protect his crops when frost comes, frost warnings, however accurate, are of no practical value to him.

Modern methods of protection, while eminently practical, involve a considerable outlay of time and money, and in general farming the area to be protected is so large that the expense in practice is prohibitive. However, there are occasions when a warning of frost twenty-four hours in advance can be used to considerable advantage. In the sugar districts of Louisiana it is desirable that the cane remain standing as long as possible, because of the rapid increase of its sugar content toward the time of maturity. However, it must be cut before frost or there is great loss. It is the practice of the cane growers to make everything ready, and when a warning that frost threatens is received large quantities of cane are cut in a single day.

The writer knows of several instances when farmers in Wisconsin made a similar use of the frost warnings of the Weather Bureau and cut large acreages of corn, thus saving it from injury. It would seem that in a State like New York, where the season is none too long to mature corn

and where every additional day that the crop stands increases its feed value, and with machinery in general use by which a large acreage may be cut in a few hours, warnings of frost might be used to great advantage.

Again, the farm orchard and garden usually are small in area and the cost of their protection by some of the simpler methods described further on would be slight compared with the returns from protection for a single night at a critical time.

Frost warnings are issued by the United States Weather Bureau generally about 10 a. m. eastern time. Occasionally, when conditions seem to warrant it, they are issued at other hours. The warnings are telegraphed to telephone exchanges, which will give the information to their patrons; so that almost any farmer who has a telephone may get the warnings by calling his exchange at 11 a. m. or shortly after. The warnings are distributed by mail, also, and are published in the newspapers.

It must be remembered that these warnings are general in character and cover a large territory. They apply to the average conditions over the territory and not specifically to the individual farm, which, because of its topography or the condition of the soil, may vary greatly from the general average in its liability to frost. Hence, the farmer who expects to obtain the greatest benefit from the warnings should accept them as applying generally to his vicinity, and should make such modification in their application to his own farm as a careful and intelligent study of local conditions seems to warrant.

FORECASTING FROST FROM LOCAL OBSERVATIONS

In the present state of knowledge it is hardly possible for one, no matter how well versed in the science of the weather he may be, to forecast frost with a fair degree of accuracy twenty-four hours in advance from observations made at a single place. The frost warnings issued by the United States Weather Bureau are based on several hundred observations taken in all parts of the United States and in Canada. However, local observations are indispensable to an intelligent use of the general warnings and may be made the basis of a fairly accurate judgment for a shorter period than twenty-four hours. Assuming that it is the season when frosts are likely to occur, the points to be considered, aside from local topography, are as follows:

1. Character of the preceding weather
2. State of the sky, whether cloudy or clear
3. Direction and force of the wind
4. Trend of the temperature
5. Atmospheric pressure

Preceding weather

The character of the preceding weather is important because damaging frosts often follow an abnormally warm period. The weather moves over the country from west to east in somewhat irregular, but nevertheless well-defined, waves. Hence, there is a strong tendency for extremes to follow each other, and such extremes are often disastrous in their effects. A light frost, particularly in spring, following an unusually warm period often will cause more damage than a severer frost preceded by cooler weather, because the warm weather forces out the blossoms prematurely and renders them more susceptible to injury. While an unusually warm period does not mean always that frost will follow, yet the fact that most frosts do follow such periods should be regarded as sufficient warning that frost is likely to occur.

State of the sky

Frost is not likely to occur when the sky is overcast because the heat given off by the earth at night does not penetrate the clouds easily and is practically all retained in the air below them, which therefore remains at a comparatively high temperature. Even a hazy condition of the sky, or the thinnest cirrus clouds, have an appreciable effect in retarding the fall of temperature at the surface. But on clear nights the heat escaping from the earth passes away quickly, almost without hindrance, far beyond the limits of the atmosphere. Hence, the fall of temperature at the surface is rapid and, unless the earth has a vast store of heat, frost is likely to occur.

Direction and force of the wind

The direction of the wind is a reliable indication of the approach of colder weather. If, after a day or two of warm southerly winds and possibly rain, the wind changes to the southwest or west, it is an almost unfailing indication that the warm spell is over, and it is well to watch closely the conditions that follow, particularly if there are signs of clearing weather. Occasionally, a frost follows when the wind backs from east or northeast to north or northwest. In either case, the conditions to be looked for as soon as the wind changes are falling temperature, decreasing wind, and a clear sky. Frost is not likely to occur unless the air becomes quiet and the sky clear, for wind prevents the accumulation of the colder air at the surface.

Trend of the temperature

The rate of fall in temperature during the late afternoon or early evening is a good indication of the lowest temperature that will be reached

during the night. For example, a temperature of 40° at about 6 p. m., with a clear sky and light wind, is considered critical; particularly is this the case if the rate of fall approximates 1° for each two hours, which, if continuous — as would be likely with a clear sky and light wind — would bring the temperature close to the freezing point by early morning. A fall in temperature of 2° per hour would indicate frost, even with the temperature considerably above 40° in the late afternoon.

Atmospheric pressure

The rate of change in the pressure of the atmosphere as indicated by the barometer is of some assistance in forecasting frost. The actual stage of the pressure, whether above or below normal, is not important, except that a warm period with unusually low pressure is likely to be followed by the opposite extreme. The important factor is the rate of change. If the pressure is increasing rapidly, as indicated by a rapid rise in the barometer, it is a good indication that the cold period or cold wave is approaching rapidly. The change in pressure usually precedes by a short interval the change in direction of the wind, because the wind depends on the pressure; but one will have to watch the barometer very closely to gain much advantage over the indications afforded by the direction and force of the wind.

THE EVENING DEW-POINT AS A GUIDE TO THE MINIMUM TEMPERATURE OF THE FOLLOWING NIGHT

Recently there has been considerable discussion as to the value of the evening dew-point as indicating the probable fall in temperature during

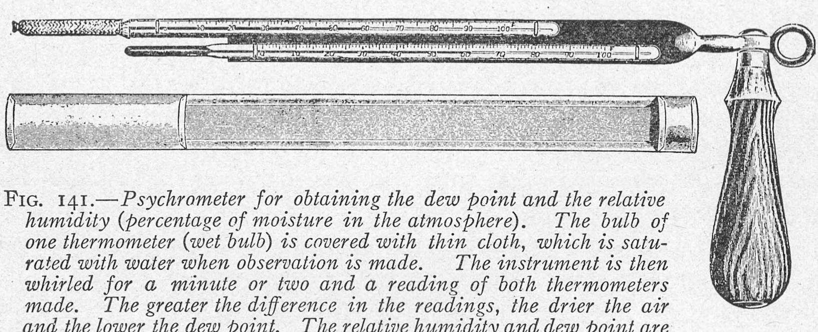

FIG. 141.—*Psychrometer for obtaining the dew point and the relative humidity (percentage of moisture in the atmosphere). The bulb of one thermometer (wet bulb) is covered with thin cloth, which is saturated with water when observation is made. The instrument is then whirled for a minute or two and a reading of both thermometers made. The greater the difference in the readings, the drier the air and the lower the dew point. The relative humidity and dew point are found by reference to tables that accompany the instrument.* *Price, $4 to $6*

the ensuing night, and in order to gain a clear understanding of this question it seems necessary to review briefly the subject of atmospheric moisture and the principles involved.

There is always more or less moisture in the air in the form of vapor. The moisture gets into the air because the heat of the sun is always changing the water on the earth into vapor. To change a pint of water into vapor requires a little more heat than would raise the temperature of five pints of water from the freezing to the boiling point. Conversely, the vapor in the air always may be changed again into water if the temperature be sufficiently lowered, and when so changed the heat used originally to evaporate the water is released, or "liberated," and becomes available to warm the air, just as addition of heat from any outside source may do.

The dew point is the temperature at which the change from vapor to water begins, and is, therefore, the temperature at which the release of heat begins also. On these facts is based the belief that if the dew point is above freezing, the addition of heat to the air as dew continues to form — for dew is the result of change from vapor to water — will check, or at least retard, the fall in temperature and thus tend to prevent frost. On the other hand, if the dew point is below freezing, no retarding effect can be expected until the formation of frost has taken place. Thus, the dew-point temperature during the early evening, because it shows the temperature at which the release of heat may be expected to begin, has been considered a reliable guide to the lowest temperature of the following night. That its value as a guide in forecasting frost depends on general climatic conditions and varies widely in different parts of the country, seems to be borne out by the experience of a number of observers. O'Gara, in his work on "The Prevention of Frost Injury in the Orchards in the Rogue River Valley" (near Medford, Oreg.), found that there was a very close relation between the afternoon dew-point and the lowest temperature during the ensuing night. On ten clear, quiet nights when frost was likely to occur, the average evening dew-point was 34.7°, while the average of the ensuing minimum temperatures was 34.5°. The greatest difference on any night was 3° and there were several times when the evening dew-point and the following minimum temperature were the same. He considers the afternoon dew-point not only a reliable indication of whether or not frost will occur, but also a valuable guide as to the degree of frost.

Professor Cox, in his investigation of frost in the cranberry districts of Wisconsin, found that the early evening dew-point afforded "no indication whatever" of the ensuing minimum temperature. At the experiment station at Mather, Wis., during the month of September, 1907, the average dew-point temperature at 6 p. m. was 56.3° and the average of the following minima was 46.6° — an average difference of 9.7°. The variation for the different days of the month ranged from 0° to 28°; on thirteen nights the difference was 10° or more and there was only one

night when the evening dew-point and the following minimum were the same. On every night throughout the month the evening dew-point was several degrees above freezing, so that in every case the effect of the liberation of heat from condensation was operative, yet frost occurred several times. On the 25th the dew point was 40°, yet in spite of the heat released by the process of condensation the temperature fell to 25° before morning. On the 30th the dew point at 6 p. m. was 49° and a minimum of 21° was experienced during the night following — a fall of 28° from the evening dew-point, notwithstanding the continuous liberation of latent heat. It cannot be doubted that heat was liberated in the process of condensation and that it had a warming effect, but in the cases cited the amount obviously was too small to have an appreciable influence in checking the fall of temperature.

Professor Willis I. Milham, of Williams College, Williamstown, Mass., conducted a series of observations covering a period of ten years. He found the condition of the atmosphere at Williamstown with respect to moisture almost exactly the reverse of that found by Professor Cox in the cranberry districts of Wisconsin. In the cranberry districts the evening dew-point nearly always was much above the ensuing minimum temperature, so that the effect of the liberation of heat nearly always was operative. At Williamstown the evening dew-point was generally lower than the minimum reached during the following night, and, in consequence, there was no liberation of heat to retard the fall of temperature. Professor Milham summarizes his conclusions as follows:

1. The cool nights of spring, when a frost might be expected, are very dry and the dew point lies so low that it plays practically no part in determining the minimum temperature.

2. The amount of the drop from the maximum to the following minimum is very far from constant, even if the characteristics of these nights seem very nearly the same.

An examination of observations for the months of April, May, September, and October for several years, made by cooperative observers in this State, shows that practically the same conditions exist here as were found by Professor Milham at Williamstown. In this State, however, the dew-point observations were made late in the evening, at 9 p. m., but the difference in time is not considered important. If there is any advantage it should be in favor of the later observations. In many cases examined, the air at the time of observation was saturated or nearly so, so that the liberation of heat began as soon as the temperature commenced to fall; but on clear nights when frost was probable, the air was often so dry that the dew point was several degrees below the freezing point, and therefore no effect from the liberation of heat could be expected. Moreover, the difference

between the dew point at 9 p. m. and the ensuing minimum varied greatly. At Alfred, N. Y., in April, 1892, the difference ranged from 0° to 21°; on fourteen days the 9 p. m. dew-point was higher than the following minimum and on fifteen days it was lower. The following table of days when the minimum dropped to freezing or below at Alfred in April, 1892, will serve to illustrate the variation and is considered typical of the conditions found elsewhere:

Date	Air temperature 9 p. m.	Dew point 9 p. m.	Ensuing minimum	Minimum above (+) or below (—) dew point
5	64	52	31	—21
8	35	32	22	—10
23	46	41	26	—15
26	40	20	28	+ 8
30	40	30	38	+ 8

It is noticed that on the first three dates the ensuing minimum was much below the evening dew-point, and, although the liberation of heat must have been continuous, the fall of temperature apparently was checked but little if any. In the two remaining instances the minimum did not fall to the evening dew-point by a margin of 8°, which means that no heat was liberated and therefore no check was offered to the fall of temperature. In three of the five cases the cause that was expected to check the fall of temperature was operative, but apparently ineffectual, while in two cases it was not in operation even.

From the foregoing, it is apparent that this method of determining the probability and degree of frost is by no means so reliable or so general in its application as has been supposed heretofore.

For the farmer who is prepared to make practical use of a frost warning, the forecasts issued by the Weather Bureau should receive first consideration because they may be obtained early in the day, before it is possible to obtain any reliable indications from local observations as to the probability of frost. But when the warnings issued by the Weather Bureau cannot be obtained and the farmer must rely on himself, there are no instrumental readings that will take the place of a careful observation of the condition of the sky, the direction and force of the wind, and the trend of the temperature.

METHODS OF FROST PROTECTION

The object sought in all methods of frost protection is to hold the temperature of the air in contact with the plant above the point of danger. In the attempt to accomplish this certain principles are involved:

1. Prevention or retardation of the escape of heat from the earth by the use of an artificial covering. The use of smudges as a means of protection against frost is based on this principle.

2. Addition to the air of moisture in the form of vapor, with the view of obtaining the effect of liberation of latent heat as the moisture condenses. The use of damp fuel for smudges and the spraying of fires with water have this purpose in view.

3. Heating the air by numerous small fires.

Artificial covering

It is a very old practice to protect plants from frost by covering them with newspapers, carpets, straw, and the like. This is a most cleanly and efficient method, but unfortunately, because of the labor and expense involved, it is applicable in practice only to small areas, such as flower beds and gardens. However, by a small investment in tarred building paper the practice may be extended profitably to considerable areas. When the paper is cut into convenient lengths and two or three strips are fastened or pasted together so as to make a strip eight or ten feet wide, which can be rolled and unrolled easily, this method may be used for the protection of a fairly large area. It affords a very convenient and efficient protection for strawberries, garden truck, or small fruits. Paper of this kind can be purchased for one to two cents per square foot, and with care should last several years.

Smudging

Smudging, particularly when damp fuel is used, combines the first and second principles mentioned above — the prevention of the escape of heat from the ground and the addition of moisture to the air. In practice smudging has not proved a very efficient method of protection. It is used chiefly at present to shield the blossoms from the sun during the morning hours following a frost, thus preventing too rapid thawing. Spraying the frozen fruit or blossoms with water is practiced, also, with the same purpose in view. It is not so much the freezing that causes injury, as too rapid thawing. It is said that blossoms may be frozen solid for several hours without injury if thawed very slowly.

Heating the air

The most practical, efficient, and economical method yet devised for protection of large areas is the direct addition of heat by means of numerous small fires properly distributed over the area to be protected.

For the farmer who desires to protect the farm orchard, this method is offered as neither difficult nor expensive. However, it does require foresight and careful preparation. The fuel to be used must be on the ground and ready for instant use. Moreover, it must be dry, so that fires may be started quickly when the temperature approaches the point

FIG. 142.—*Orchard owned by J. G. Gore, Medford, Oreg. Crop, valued at $1,000 per acre, has been saved four years in succession by the use of old rails for fuel purposes*

of danger. A small investment in an alarm thermometer will obviate the inconvenience of remaining up at night to watch for the time when the fires must be started. These thermometers are constructed to ring an alarm bell when the temperature approaches the danger point. The alarm thermometer should be located in the coldest part of the orchard and set to ring the bell when the temperature is still a few degrees above the point of danger, so as to give time to get the fires started.

Wood, coal, and oil are the fuels in use, and the choice must depend on local price and supply.

Wood.—For the general farmer in New York who wishes to protect merely the farm orchard, open wood fires probably are the most economical.

The prunings from the ordinary orchard generally are not sufficient, but they should be saved and kept dry for use in starting the fires. Old rails or cordwood make good fuel, and when piled dovetail fashion, with a little dry kindling at the bottom, are easily lighted. J. G. Gore of Medford, Oreg., saved his crop, valued at $1,000 per acre, four years in succession by the use of old rails for fuel.

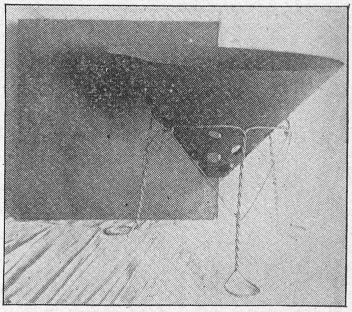

FIG. 143.—*Coal heater*

A little dash of kerosene or crude oil and the application of the torch is all that is necessary to light the fires. An iron rod three or four feet long, wound at one end with cotton waste or rags and saturated with oil, makes a serviceable torch.

The number of wood fires necessary to protect an orchard of large trees ranges from twenty-five to fifty per acre, depending on the degree of frost and the strength of the wind. The fires should not be large, since large fires tend to set up currents that draw in the cold air outside and thus may defeat the purpose in view. In practice it is best to prepare the maximum number, but to light only every other one at first, holding the others in reserve in case the fall of temperature is not checked. Usually it is possible to hold the temperature in an orchard in this way 6 to 10° above the temperature outside. It sometimes happens that even this is not sufficient and that some of the blossoms will be frosted, particularly in the colder parts of the orchard. When this occurs it is good practice to use the fires to create a dense smudge about sunrise, with a view of retarding the process of thawing. For this purpose coarse manure, sawdust, wet straw, and the like, may be used.

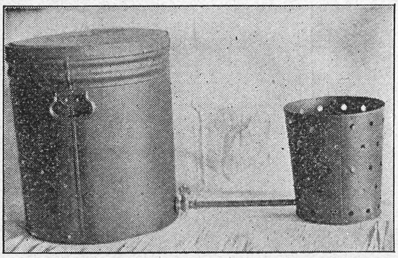

FIG. 144.—*Richardson reservoir heater*

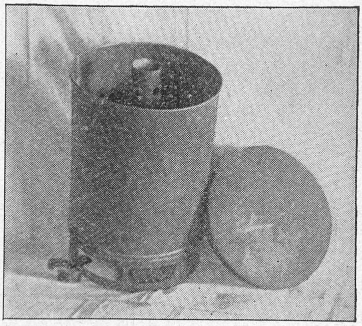

FIG. 145.—*Troutman heater*

Coal.—Coal makes an excellent fuel and in some instances is cheaper than wood. The use of wire baskets suspended from the trees or from tripods placed between the rows

generally has been discarded, because the baskets will not retain their shape when heated. The most satisfactory coal burner is an inverted cone made of sheet iron perforated at the bottom for draft and holding perhaps half a bushel of coal. It is placed a few inches above the ground and supported on iron legs. The coal burners should be prepared in advance, so as to be lighted quickly when the temperature approaches the danger point. From twenty-five to fifty heaters per acre usually are considered sufficient for the ordinary orchard of medium age, but for young orchards the number should be increased. A medium grade of soft coal makes a satisfactory fuel, and twenty-five to thirty pounds per heater is sufficient for four hours burning. For the greater part of New York about $2 per night per acre, exclusive of labor in handling, probably would be the maximum cost of heating with coal.

FIG. 146.—*Rayo orchard heater*

Oil.— For the commercial orchardist, oil is probably the most economical fuel, not because it is more efficient than wood or coal, but because it is more easily handled. Crude oil and distillate are used chiefly for this purpose. Crude oil is the cheaper, but is less satisfactory because it contains a certain percentage of water, which tends to extinguish the flame and causes the pots to boil over. Also, it is difficult to handle in cold weather and in burning it gives off large quantities of soot. Distillate is a by-product of crude oil remaining after the kerosene and gasoline have been extracted. It is free from water, ignites readily, burns freely, and leaves little residue. The question of an oil fuel that is satisfactory both in price and in efficiency is not yet settled.

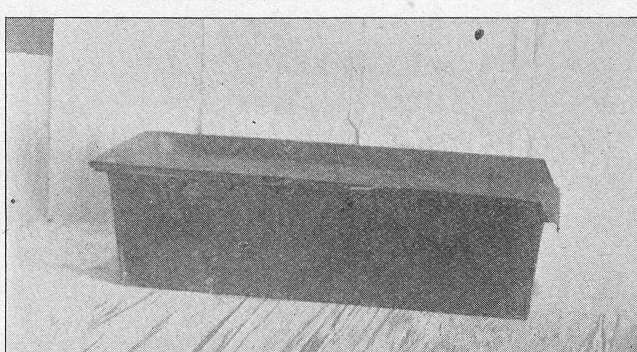

FIG. 147.—*Hamilton orchard heater. When in use the cover is partly withdrawn*

Probably more than fifty different styles of oil-burning orchard heaters have been placed on the market. Some are little more than a large lard pail, while others are fitted with soot arresters, feeds for controlling the flow of the oil, and various more or less complicated devices. Extensive field tests have shown that the simpler devices are quite as efficient as those of more complicated construction, are less likely to get out of order, and cost less.

Good practical heaters can be purchased in large lots for about 32 cents each. The number of heaters required per acre ranges from sixty for old orchards to one hundred for young orchards, old orchards with wide-spreading trees being less difficult to heat than young orchards. The cost of heating with oil (sixty heaters per acre), including cost of handling and interest on the investment, was found by O'Gara to be about $3 per night per acre. This was based on burning the heaters four hours per night, which is about the time necessary under average conditions.

WILL ORCHARD HEATING PAY IN NEW YORK?

In some parts of the country, particularly in the fruit-growing districts of the Pacific States, orchard heating is regarded as a necessity. In the commercial fruit-growing districts of New York the same necessity does not exist, because of an exceptionally favorable climate. This does not mean that frost protection in New York would be an unprofitable undertaking, but merely that fruit growing in New York is profitable in spite of occasional losses by frost. Every fruit grower carries a certain frost risk, which is a fixed charge against the crop. He may not have to settle the account this year or next, but the day of settlement is sure to come. The frost risk, even in the most favored parts of the fruit belts of New York, is greater than the risk of loss by fire, yet few farmers fail to insure against a loss of the latter character. Frost protection should be regarded as an insurance against loss by frost, and the cost of this kind of insurance is the cost of heating. Now, if it is possible to determine the annual frost risk and the average cost of heating per season, it is possible to determine whether or not orchard heating will be a profitable investment.

Hedrick says that during the past twenty-five years fruit was practically ruined by frost in western New York in four years — 1889, 1890, 1895, and 1902. In four other years — 1888, 1891, 1893, and 1903 — the damage was considerable; while in three years — 1892, 1896, and 1900 — the damage was slight and confined to early fruits. A careful examination of the temperatures during the blooming period in these years confirms his conclusions. This would indicate that the frost risk must be considerable.

Take, for example, an orchard located at Appleton, Niagara county, where the risk from frost is smaller, perhaps, than in most other parts

of the State. An examination of temperatures at Appleton for the month of May in the past twenty years shows that temperatures occurred possibly in three, and certainly in two, years, that in all probability resulted in a total loss of crop. In 1890 the temperature fell to 27° on the night of May 9, and in 1902 to 26° on May 11. Damaging frosts occurred also in May in 1891, 1895, 1903, and 1907. (Fig. 149.) Assuming that the value of a normal crop in this orchard was $125 per acre, and that there was a total loss of crop in two years and a loss of one half the crop in four other years, the total loss in the twenty years would amount to $500 per acre, which is an annual loss of $25 per acre and represents the annual frost risk carried. In May in the past twenty years the temperature at Appleton fell to freezing or below (the lowest being 26°) thirty-four times, and, while a temperature of 32° is not necessarily injurious to orchard fruits, it indicates such a critical condition that a grower, if prepared, would not be justified in waiting longer before starting the fires.

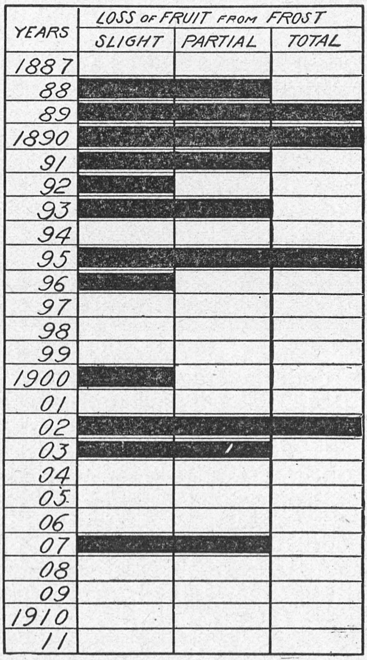

FIG. 148.—*Frost injury in western New York, twenty-five years, 1887 to 1911. A partial loss shown for 1907 is not included in Hedrick's statement*

Accepting O'Gara's experience of the cost of heating as $3 per acre per night, the total cost for the twenty years, heating thirty-four times, would amount to $102, or an annual cost of $5.10 per acre. This with the cost of the plant, $19.20 (60 heaters at 32 cents each), would make a total outlay the first season of $24.30.

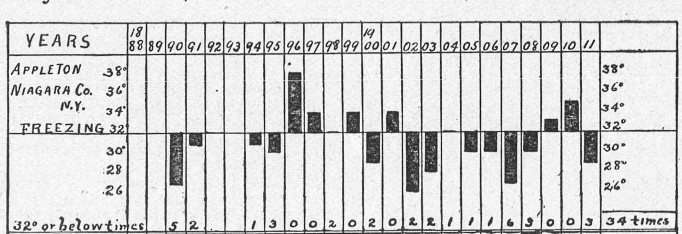

FIG. 149.—*Lowest May temperatures at Appleton, N. Y., with number of times freezing temperatures were recorded in each year. No record made in May, 1892, nor in May, 1893*

Thus, the risk for a single year, $25, would more than pay for the cost of the plant plus the cost of heating in the first season.

When orchard heating is undertaken extensively, tanks, hose, and other apparatus are necessary additional items of expense. But when it is remembered that a single outfit will take care of 15 or 20 acres, the expense per acre is very small. It is believed that the general farmer with only a small orchard, as well as the commercial fruit grower, would do well to consider orchard heating as a means of protecting against frost in the light of a profitable investment.

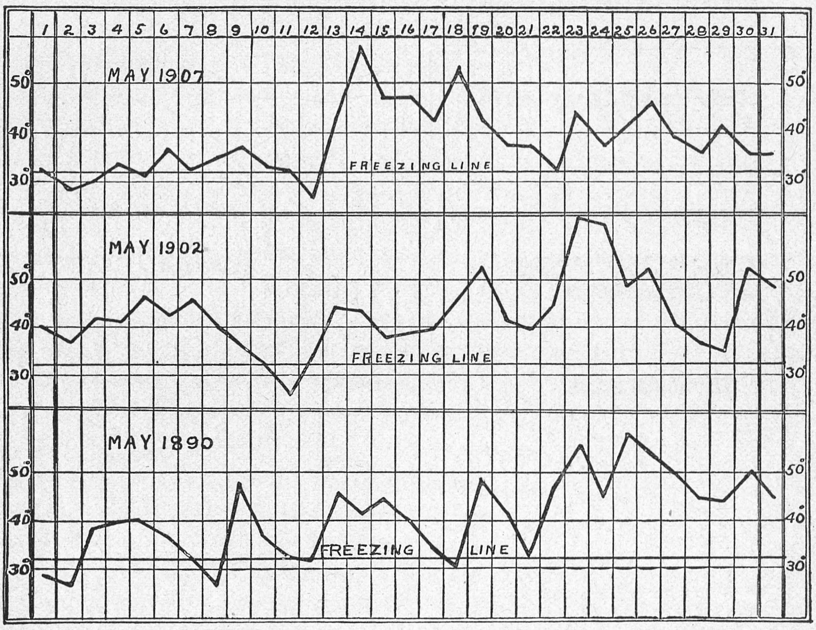

FIG. 150.—*Minimum temperatures at Appleton, Niagara county, for May, 1907, 1902, and 1890*

HOW TO OBTAIN INFORMATION ABOUT THE CLIMATE

The United States Weather Bureau, in cooperation with the New York State College of Agriculture, has on file the records of temperature, rainfall, sunshine, frost, and so on, made in nearly all parts of the State. All available information of this character may be obtained on application to The Section Director, Local Office, Weather Bureau, Ithaca, N. Y.

Similar information has been collected and is available for nearly every locality in the United States. Those who are contemplating the agricultural opportunities of any part of the country with whose climate they are not familiar would do well to consult these records. Records of this character are made under the supervision of the Weather Bureau and give the facts as they exist, without bias or color. Requests for infor-

mation on the climate of regions outside of New York State, should be addressed to Chief of Weather Bureau, Washington, D. C.

FROST RECORDS IN NEW YORK AND THEIR APPLICATION

Arrangement of frost table

1. Alphabetically by climatic divisions
2. Alphabetically by counties under climatic divisions
3. Alphabetically by places under the county

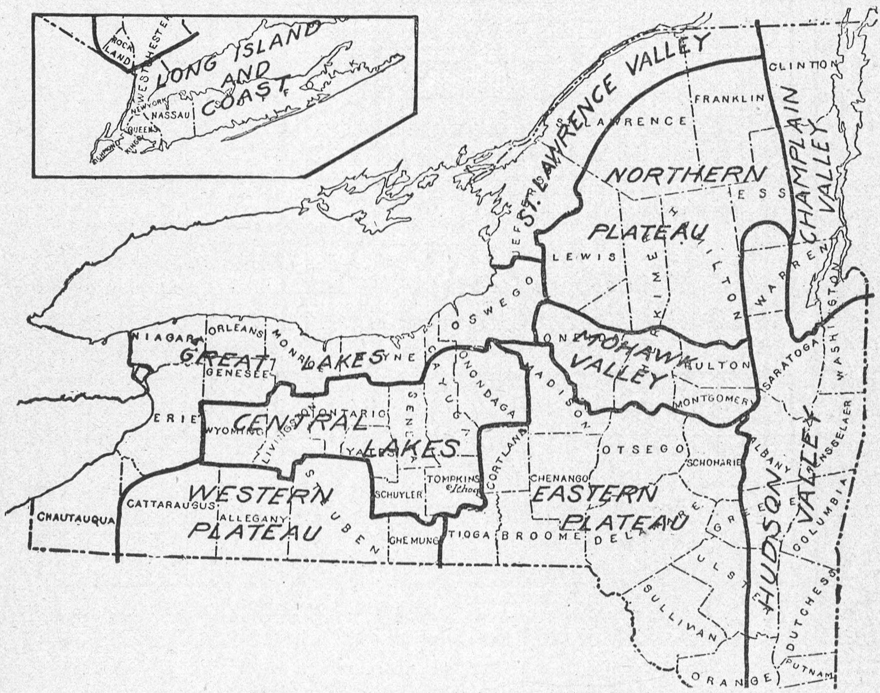

FIG. 151.—*Climatic divisions of New York*

The climatic divisions are as follows:

1. Central Lakes, pages 536–537
2. Champlain Valley, pages 536–537
3. Eastern Plateau, pages 536–539
4. Great Lakes, pages 538–539
5. Hudson Valley, pages 540–541
6. Long Island and Coast, pages 540–541
7. Mohawk Valley, pages 540–541
8. Northern Plateau, pages 542–543
9. St. Lawrence Valley, pages 542–543
10. Western Plateau, pages 542–543

Example — To find the frost record for Cooperstown, Otsego county:

By reference to the chart (Fig. 151) Otsego county is found in the Eastern

Plateau division, and the frost records for observation stations in the Eastern Plateau appear on pages 536–539 for spring and fall, respectively.

Explanation of table

The record given in each case covers the entire period for which authentic information is available. When no specific reference to killing frost was made in the record, the last occurrence of a freezing temperature in the spring and the first in the fall were considered as equivalent to killing frosts.

As an example, take the spring frosts at Auburn, Cayuga county, in the Central Lakes division (page 536). The data in the first four columns need no explanation. In the columns that follow, the figures represent the number of years in which the last killing frost in spring occurred within the dates given at the head of each column, which are five-day periods. In the column headed " 15 or before " under April, appears the figure 1, which means that there was one season in the 14 years of record when the last killing frost occurred on or before April 15. Under May, in the column headed " 1–5," is the figure 4, which means that in 4 out of the 14 seasons the last killing frost occurred between May 1 and 5, inclusive. The sum of the figures in the columns under May is 10, which means that in 10 out of 14 seasons killing frosts occurred after May 1.

The record of the first killing frosts in the fall is tabulated in a similar manner. The figure 1, in the column headed "21–25" under September, means that killing frost occurred within the five days, September 21 to 25 inclusive, in 1 out of 14 seasons. The sum of the figures in the columns preceding any date gives the number of seasons out of the years of record in which killing frosts occurred previous to that date. Thus, the sum of the figures preceding October 11 is 7, which means that killing frosts occurred before October 11 in 7 out of 14 seasons.

Practical application of frost records

The character of the seasons at a given place as shown by actual records of past years, is the best guide we have to the character of the seasons at that place in future years.

Consider, for example, the frost record of Wedgwood, Schuyler county (pages 536–537), with a view to determining the most favorable time for planting corn in that vicinity. By consulting the record of frosts at Wedgwood it is found that killing frosts occurred after May 20 in 5 out of 22 seasons, after May 25 in 1 out of 22 seasons, and that there were no killing frosts after June 1. If, during the 22 years, corn had been planted so as to be up on May 20 it would have been frosted in 5 out of

the 22 years; if planted five days later, in 1 out of the 22 years; but if planted so as to be up on June 1 it would have escaped frost in all of the 22 seasons and the risk of frost in the spring would have been eliminated entirely. But fall frosts must be considered. Allowing eight days for germination, about 112 days are required to mature corn in this climate after it is up. From June 1 to September 15 is only 107 days, yet with so short a season as this the crop would have been frosted in the fall in 2 out of 23 years. Therefore it is evident in this case that the frost risk could not be eliminated wholly, and must be carried at one end of the season or the other. If, during the 22 years, the crop had been planted so as to be up on May 20, thus eliminating the fall risk, the spring risk would have been 5 out of 22, a rather heavy risk; if planted five days later, thus dividing the risk between spring and fall, the crop would have been frosted once in the spring and twice in the fall, a total of 3 times in the 22 years; but if planted late enough to escape the spring frosts, carrying the entire risk at the fall end of the season, it would have been possible to have made 20 crops in the 22 years without any injury from frost whatever. Moreover, since there were no frosts between September 15 and 20, a season of 117 days could have been obtained instead of 112 days without increasing the frost risk at either end of the season.

For any crop subject to injury from frost in either spring or fall it is possible in this way to determine the schedule that would have produced the best results in the past; and it is reasonable to assume that the crop scheme that was best in the past will prove best for the future also.

The frost record of a given locality should be of assistance as well in the selection of varieties that will be likely to mature in that locality. For example, the record for Baldwinsville shows that no frost occurred after June 1 in 18 years and in only 2 years before October 1. Thus, counting from the date of planting, May 22, a variety requiring 130 days to mature might be grown with a risk from frost in only 2 out of 18 seasons. At Wedgwood the risk for the same variety would be 5 seasons out of 23. At Shortsville, where no frosts have occurred in the fall before October 5 in 12 years, it would seem that a variety requiring 135 days to mature might be grown successfully.

It is understood that exigencies of soil or weather may at times interfere with any plan that may be devised; but the nearer the approach to the ideal in agricultural practice, which is the adaptation of the crop scheme to the climate, the better will be the results obtained.

In using the records given to determine the risk of injury by frost to tree fruits, it should be remembered that the records are based on temperatures taken mostly at a height of about four feet above ground; and for the

reasons given on page 511, the risk of injurious temperatures at the height of the blossoms probably is considerably less than would appear from the tables. For example, the record made at Appleton, Niagara county, shows that freezing temperatures occurred after May 1 in 14 out of 21 years; but a careful study of the temperature record in detail, particularly in connection with the dates when the various fruits come into bloom (which always must be considered), warrants the statement that fruits in that vicinity were injured actually in only about 6 out of the 21 years, and in only two seasons did the injury approach a total loss. From this and other studies, it is believed that about one third the number of the frosts given in the table after any date in May will approximate the actual frost risk to which tree fruits are subject in a given locality.

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
CENTRAL LAKES															
CAYUGA															
Auburn	715	14	161	May 5	1	0	1	2	4	1	3	0	2	...	....
Fleming	1,000	10	169	April 26	2	2	0	3	0	1	1	1	...	...	....
King Ferry	......	7	150	May 14	...	...	...	...	3	0	0	1	3	...	....
LIVINGSTON															
Avon	585	15	146	May 13	...	1	1	0	3	1	3	0	3	3	....
Hemlock Lake	900	14	167	May 3	1	1	1	2	4	3	1	0	0	1	....
Hunt	1,321	7	135	May 20	...	...	...	1	1	0	1	0	1	2	1
ONONDAGA															
Baldwinsville	385	18	168	April 29	5	0	3	3	2	0	2	0	2	1	....
Fayetteville	530	10	154	May 13	...	...	1	1	3	0	1	0	1	2	1
Syracuse	597	9	175	April 27	1	0	3	1	4	...	...	...	...	...	....
ONTARIO															
Shortsville	*740	12	164	May 7	...	1	1	0	5	0	3	0	1	1	....
SCHUYLER															
Perry City	1,038	22	132	May 18	...	...	1	0	3	3	4	3	3	2	3
Wedgwood	1,430	22	155	May 5	1	1	0	2	3	2	5	3	4	1	....
SENECA															
Romulus	719	19	156	May 9	3	0	1	2	3	2	2	2	3	1	....
TOMPKINS															
Ithaca	928	32	159	May 4	3	1	3	3	8	5	5	0	2	2	....
YATES															
Penn Yan	750	6	167	May 2	1	0	0	1	1	1	2	...	...	...	....
CHAMPLAIN VALLEY															
CLINTON															
Chazy	151	9	148	May 10	...	...	2	1	2	0	0	0	4	...	....
Dannemora	1,490	6	141	May 16	...	...	...	...	3	0	0	1	0	1	1
Harkness	622	10	148	May 12	...	...	1	0	5	0	0	0	2	0	2
Plattsburg	125	20	156	May 8	1	1	1	4	5	0	3	2	1	1	1
ESSEX															
Ticonderoga	344	13	156	May 6	1	1	1	2	2	1	3	0	1	0	1
WARREN															
Lake George	350	14	150	May 9	...	...	1	2	3	2	2	1	3	...	....
WASHINGTON															
Carvers Falls	243	14	138	May 14	...	...	1	0	0	4	3	0	6	...	....
EASTERN PLATEAU															
BROOME															
Binghamton	875	21	154	May 16	1	2	4	0	3	2	3	2	3	1	....
CHENANGO															
Norwich	1,015	5	148	May 10	...	...	...	1	1	1	0	1	1	...	....
Oxford	938	22	132	May 17	...	...	1	0	1	4	3	3	5	4	1
CORTLAND															
Cortland	1,030	18	139	May 16	1	0	1	1	2	4	3	3	1	1	1

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
CENTRAL LAKES															
CAYUGA															
Auburn	715	14	161	Oct. 13	...	...	1	0	2	4	1	2	2	2	....
Fleming	1,000	12	169	Oct. 12	1	0	0	2	1	1	2	3	0	1	1
King Ferry	......	7	150	Oct. 11	...	...	...	...	2	1	3	0	0	1	....
LIVINGSTON															
Avon	585	15	146	Oct. 6	2	0	1	1	5	1	1	2	1	1	....
Hemlock Lake	900	14	167	Oct. 17	...	...	...	...	2	2	2	3	2	3	....
Hunt	1,321	8	135	Oct. 2	1	0	1	1	2	1	1	1	...	...	....
ONONDAGA															
Baldwinsville	385	18	168	Oct. 14	1	0	1	0	2	4	3	1	2	2	2
Fayetteville	530	11	154	Oct. 14	...	...	1	1	0	1	3	1	2	2	....
Syracuse	597	9	175	Oct. 19	...	...	...	...	0	2	2	0	2	3	....
ONTARIO															
Shortsville	740	12	164	Oct. 18	...	...	...	...	0	2	2	3	2	3	....
SCHUYLER															
Perry City	1,038	22	132	Sept. 27	4	4	4	1	3	2	2	0	1	1	....
Wedgwood	1,430	23	155	Oct. 7	2	0	2	1	4	6	4	2	2	...	....
SENECA															
Romulus	719	22	156	Oct. 12	1	0	1	1	3	3	3	6	3	1	....
TOMPKINS															
Ithaca	928	33	159	Oct. 10	2	0	2	1	4	8	6	5	3	2	....
YATES															
Penn Yan	750	7	167	Oct. 16	...	...	...	...	2	1	0	1	1	2	....
CHAMPLAIN VALLEY															
CLINTON															
Chazy	151	9	148	Oct. 5	...	1	1	0	3	2	0	1	1	...	....
Dannemora	1,490	6	141	Oct. 4	...	...	1	1	1	1	2	...	...	...	....
Harkness	622	10	148	Oct. 7	1	0	1	0	2	3	0	1	2	...	....
Plattsburg	125	17	156	Oct. 11	...	...	1	2	2	6	1	3	2	...	....
ESSEX															
Ticonderoga	344	12	156	Oct. 9	1	1	0	0	2	4	0	2	1	1	....
WARREN															
Lake George	350	14	150	Oct. 6	2	0	1	0	2	5	1	1	2	...	....
WASHINGTON															
Carvers Falls	243	14	138	Sept. 29	2	3	2	1	1	2	1	1	1	...	....
EASTERN PLATEAU															
BROOME															
Binghamton	875	22	154	Oct. 17	1	2	2	3	2	3	4	3	1	1	....
CHENANGO															
Norwich	1,015	6	148	Oct. 5	1	0	0	0	2	0	2	1	...	...	....
Oxford	938	22	132	Sept. 26	6	2	3	4	2	0	4	1	...	...	....
CORTLAND															
Cortland	1,030	19	139	Oct. 2	2	1	2	2	4	4	2	2	...	...	....

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
EASTERN PLATEAU (*Continued*)															
DELAWARE															
Griffin Corners	2,260	11	115	May 24	...	...	...	...	...	...	2	2	3	1	3
South Kortright	1,441	16	109	May 27	...	...	...	...	...	1	1	2	4	4	4
GREENE															
Windham	1,520	12	130	May 17	...	...	1	0	2	1	0	2	3	2	1
MADISON															
Bouckville	1,350	14	142	May 8	2	0	0	0	2	2	4	1	2	1	....
De Ruyter	1,300	9	133	May 21	...	...	...	...	2	0	1	1	1	3	1
ORANGE															
Middletown	700	17	183	April 17	8	2	2	2	1	1	1	...	...	...	....
Port Jervis	470	22	162	May 1	1	2	3	5	4	3	2	2	...	...	....
Salisbury Mills	314	5	150	May 11	...	...	1	1	0	0	2	0	0	0	1
OTSEGO															
Cooperstown	1,250	21	148	May 8	...	1	2	4	2	0	5	3	3	1	....
New Lisbon	1,234	20	123	May 23	...	...	...	...	1	3	2	1	4	5	4
Oneonta	1,112	16	139	May 10	...	1	2	0	1	4	1	2	5	...	....
SULLIVAN															
Jeffersonville	1,240	8	134	May 16	...	...	1	0	1	1	1	0	1	2	1
Liberty	2,300	13	149	May 8	1	1	1	0	2	2	2	1	1	1	1
TIOGA															
Newark Valley	825	4	128	May 24	...	...	...	...	...	...	...	...	4	...	....
Straits Corners	600	9	118	May 26	...	...	...	...	...	1	2	1	2	1	2
Waverly	824	19	135	May 15	...	...	1	0	2	4	3	2	2	5	....
ULSTER															
Mohonk Lake	1,245	15	172	April 26	4	0	2	2	3	3	1	...	...	...	....
GREAT LAKES															
CHAUTAUQUA															
Jamestown	1,328	13	146	May 9	...	...	4	0	1	3	0	0	4	1	....
Volusia	1,167	12	153	May 8	...	...	2	0	4	2	2	0	1	1	....
Westfield	867	15	172	May 2	1	1	2	0	5	3	2	0	1	0	....
ERIE															
Alden	846	4	161	May 3	...	1	0	0	1	1	1	...	...	...	....
Buffalo	767	41	174	April 25	9	5	10	3	8	2	1	1	2	0	....
GENESEE															
Elba	500	12	156	May 6	...	1	1	0	5	2	1	1	1	0	....
Le Roy	920	12	152	May 7	...	...	1	3	3	0	2	2	1	0	....
MONROE															
Brockport	537	16	168	May 2	1	1	1	3	5	0	4	1	0	0	....
Rochester	523	20	175	April 25	7	0	3	3	2	0	3	0	1	1	....
NIAGARA															
Appleton	270	21	164	May 4	1	2	3	1	4	3	4	2	1	0	....
Lockport	650	20	168	April 30	4	1	2	3	4	0	3	2	1	0	....
ORLEANS															
Ridgeway	.....	10	167	May 4	0	2	1	0	2	2	2	0	0	1	....
OSWEGO															
Oswego	335	21	174	April 28	5	1	3	5	1	2	1	0	1	2	....
Palermo	460	10	144	May 6	2	0	0	1	0	2	1	1	1	1	1
WAYNE															
Lyons	426	17	175	April 25	4	2	2	3	2	1	3	0	0	0	....

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
EASTERN PLATEAU *(Continued)*															
DELAWARE															
Griffin Corners	2,260	10	115	Sept. 16	5	3	0	2	...	...	...	...	...	...	....
South Kortright	1,441	17	109	Sept. 13	4	3	6	3	0	1	...	...	...	...	....
GREENE															
Windham	1,520	12	130	Sept. 24	3	2	1	2	2	2	...	...	...	...	....
MADISON															
Bouckville	1,350	15	142	Sept. 27	3	1	2	2	2	3	1	1	...	...	....
De Ruyter	1,300	9	133	Oct. 1	2	0	1	1	1	2	1	0	1	...	....
ORANGE															
Middletown	700	18	183	Oct. 17	...	...	1	0	2	1	2	4	5	2	1
Port Jervis	470	22	162	Oct. 10	1	0	1	3	2	2	4	2	6	1	....
Salisbury Mills	314	5	150	Oct. 8	...	1	0	0	0	1	2	1	...	...	....
OTSEGO															
Cooperstown	1,250	22	148	Oct. 3	3	2	3	2	2	3	3	2	2	...	....
New Lisbon	1,234	20	123	Sept. 23	5	3	3	6	0	0	1	2	...	...	....
Oneonta	1,112	18	139	Sept. 26	5	2	2	3	2	2	1	1	...	...	....
SULLIVAN															
Jeffersonville	1,240	9	134	Sept. 27	1	1	1	3	2	0	1	...	...	...	....
Liberty	2,300	12	149	Oct. 4	2	0	1	1	2	1	3	1	1	...	....
TIOGA															
Newark Valley	825	5	128	Sept. 29	1	0	0	0	3	1	...	...	...	...	....
Straits Corners	600	8	118	Sept. 21	2	2	2	1	1	...	...	...	...	...	....
Waverly	824	19	135	Sept. 27	5	2	2	2	1	3	1	1	1	1	....
ULSTER															
Mohonk Lake	1,245	15	172	Oct. 15	...	...	1	1	1	2	2	2	2	4	....
GREAT LAKES															
CHAUTAUQUA															
Jamestown	1,328	12	146	Oct. 2	1	0	3	2	2	2	0	1	1	...	....
Volusia	1,167	13	153	Oct. 8	...	...	1	3	0	4	3	2	...	...	....
Westfield	867	14	172	Oct. 21	...	...	...	...	1	1	3	1	3	4	1
ERIE															
Alden	846	5	161	Oct. 11	1	0	0	0	0	1	0	2	1	...	....
Buffalo	767	39	174	Oct. 16	...	...	1	3	3	8	5	4	5	8	2
GENESEE															
Elba	500	12	156	Oct. 9	1	0	0	1	1	3	3	2	1	...	....
Le Roy	920	13	152	Oct. 6	1	0	1	2	2	3	2	1	1	...	....
MONROE															
Brockport	537	15	168	Oct. 17	...	...	...	...	1	2	4	2	2	4	....
Rochester	523	21	175	Oct. 17	...	...	...	1	1	3	4	5	2	4	1
NIAGARA															
Appleton	270	23	164	Oct. 15	...	...	1	1	4	4	4	2	2	5	....
Lockport	650	20	168	Oct. 15	...	...	1	1	2	3	3	3	1	5	1
ORLEANS															
Ridgeway	......	10	167	Oct. 18	...	...	...	...	1	3	0	2	1	3	....
OSWEGO															
Oswego	335	21	174	Oct. 19	...	...	1	0	1	3	2	4	1	8	1
Palermo	460	11	144	Sept. 27	2	2	1	1	1	3	0	1	...	...	....
WAYNE															
Lyons	426	18	175	Oct. 17	...	...	...	...	2	3	2	6	3	0	2

LAST KILLING FROSTS IN SPRING

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
HUDSON VALLEY															
ALBANY															
Albany	97	21	176	April 24	6	1	4	3	4	0	3	...	...	...	....
West Berne	600	14	133	May 15	...	1	1	0	2	1	2	0	4	1	2
COLUMBIA															
Chatham	470	7	149	May 13	...	...	...	1	2	0	1	0	3	...	....
DUTCHESS															
Honeymeadbrook	450	11	154	May 4	1	0	2	1	1	4	1	0	1	...	....
Wappingers Falls	110	19	171	April 27	3	3	3	2	3	2	2	1	...	...	....
GREENE															
Athens	90	10	162	May 3	1	0	3	0	2	1	2	0	0	1	....
ORANGE															
West Point	167	14	182	April 20	5	1	4	2	0	2	...	...	...	...	....
PUTNAM															
Carmel	500	17	168	April 26	3	2	3	1	3	4	1	...	...	...	....
SARATOGA															
Ballston Lake	400	8	154	May 6	...	...	1	1	4	0	0	0	2	...	....
Greenfield Center	314	13	150	May 5	1	0	2	2	3	0	2	1	2	...	....
Spier Falls	400	9	139	May 8	...	...	1	1	4	0	1	0	1	1	....
WARREN															
Glens Falls	340	18	148	May 7	1	1	1	2	5	1	2	1	4	...	....
North Creek	1,002	4	131	May 17	...	...	...	...	1	1	0	0	0	1	1
WASHINGTON															
Greenwich	425	14	151	May 10	...	...	1	1	4	2	2	0	3	1	....
LONG ISLAND AND COAST															
NEW YORK															
New York	314	38	210	April 10	29	5	2	2	...	...	...	...	...	...	....
SUFFOLK															
Cutchogue	32	13	181	April 24	3	0	4	2	1	1	2	...	...	...	....
Setauket	40	22	206	April 16	12	3	5	0	0	0	0	1	0	1	....
Southampton	36	11	184	April 23	4	1	2	1	1	0	1	0	0	1	....
Wading River	112	6	168	May 7	...	...	...	1	2	2	0	0	1	...	....
WESTCHESTER															
Bedford	290	16	157	May 3	1	2	1	3	3	1	2	1	1	1	....
Mount Hope	200	14	170	April 27	1	2	5	2	1	0	2	0	1	...	....
Scarsdale	200	8	170	April 29	1	1	2	0	2	0	2	...	...	...	....
MOHAWK VALLEY															
FULTON															
Gloversville	850	20	139	May 10	1	0	1	3	3	3	3	0	4	1	1
HERKIMER															
Little Falls	924	15	156	May 4	1	1	1	2	4	2	3	0	1	...	....
Salisbury	1,526	15	125	May 19	...	...	...	...	1	2	4	1	2	3	2
MONTGOMERY															
Amsterdam	277	8	163	April 28	...	...	4	1	2	0	1	...	...	...	....
Fort Plain	316	7	152	May 10	...	...	1	0	3	0	1	0	1	1	....

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column										
					September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
HUDSON VALLEY															
ALBANY															
Albany	97	21	176	Oct. 17	...	...	1	0	1	6	5	4	2	2	....
West Berne	600	13	133	Sept. 25	2	4	2	1	2	1	0	0	1	...	....
COLUMBIA															
Chatham	470	7	149	Oct. 9	1	0	0	0	2	1	2	0	1	...	....
DUTCHESS															
Honeymeadbrook	450	10	154	Oct. 5	1	0	1	1	1	2	0	3	1	...	....
Wappingers Falls	110	19	171	Oct. 15	1	0	1	0	1	2	4	4	3	2	1
GREENE															
Athens	90	10	162	Oct. 12	...	...	1	0	1	1	4	1	1	1	....
ORANGE															
West Point	167	14	182	Oct. 19	...	...	...	2	1	2	2	0	1	4	2
PUTNAM															
Carmel	500	16	168	Oct. 11	1	0	1	1	0	4	4	2	2	1	....
SARATOGA															
Ballston Lake	400	8	154	Oct. 7	...	...	1	1	1	3	1	0	0	1	....
Greenfield Center	314	14	150	Oct. 2	1	1	1	0	4	4	2	0	1	...	....
Spier Falls	400	10	139	Sept. 24	3	0	3	1	1	2	...	...	...	...	....
WARREN															
Glens Falls	340	19	148	Oct. 2	3	1	2	2	3	3	2	2	1	...	....
North Creek	1,002	4	131	Sept. 25	1	1	0	1	0	1	...	...	...	...	....
WASHINGTON															
Greenwich	425	14	151	Oct. 8	...	...	1	1	5	2	1	2	2	...	....
LONG ISLAND AND COAST															
NEW YORK															
New York	314	39	210	Nov. 6	...	...	...	...	...	...	1	0	4	8	26
SUFFOLK															
Cutchogue	32	13	181	Oct. 22	...	...	...	...	1	1	1	2	3	4	1
Setauket	40	23	206	Nov. 8	...	...	...	...	...	...	...	...	2	3	18
Southampton	36	11	184	Oct. 24	...	...	...	...	...	1	1	2	1	5	1
Wading River	112	6	168	Oct. 22	...	...	...	...	...	1	2	0	0	2	1
WESTCHESTER															
Bedford	290	17	157	Oct. 7	2	0	2	1	1	1	2	3	3	1	1
Mount Hope	200	14	170	Oct. 14	...	...	1	0	1	2	4	2	3	1	....
Scarsdale	200	8	170	Oct. 16	...	...	1	0	1	0	1	2	1	2	....
MOHAWK VALLEY															
FULTON															
Gloversville	850	20	139	Sept. 26	3	4	3	5	2	2	0	0	1	...	....
HERKIMER															
Little Falls	924	15	156	Oct. 7	2	0	1	1	3	3	1	1	1	2	....
Salisbury	1,526	15	125	Sept. 21	4	5	1	2	2	1	...	...	...	...	....
MONTGOMERY															
Amsterdam	277	9	163	Oct. 8	1	0	1	0	1	2	2	0	1	1	....
Fort Plain	316	7	152	Oct. 10	...	...	1	0	0	2	3	0	0	1	....

Last Killing Frosts in Spring

	Elevation	Years record	Average length of season (days)	Average date of last frost	Number of years last frost occurred within 5-day periods, ending with date at head of column										
					April				May						June
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
NORTHERN PLATEAU															
ESSEX															
Keene Valley	1,000	14	118	May 24	...	...	...	...	1	0	2	3	1	2	5
Saranac Lake	1,620	14	114	May 22	...	...	...	...	2	1	3	1	0	1	6
South Schroon	1,225	6	119	May 20	...	...	1	0	0	0	0	0	3	2	....
FRANKLIN															
Gabriels	1,729	12	94	June 5	...	...	...	...	...	1	1	1	0	0	9
Tupper Lake	1,552	9	107	June 1	...	...	...	...	...	...	2	0	2	1	4
HAMILTON															
Indian Lake	1,705	12	84	June 12	...	...	...	...	...	...	...	1	0	1	10
North Lake	1,822	10	122	May 29	...	...	...	...	...	...	...	2	3	0	5
LEWIS															
Lowville	900	20	134	May 15	...	...	...	3	2	2	3	4	4	0	2
Number Four	1,571	15	112	May 22	...	...	...	...	1	1	3	2	3	1	4
ST. LAWRENCE VALLEY															
FRANKLIN															
Moira	200	12	142	May 13	...	...	1	2	2	0	2	0	3	1	1
JEFFERSON															
Adams Center	540	9	146	May 15	...	...	...	...	5	0	1	0	0	2	1
Cape Vincent	246	7	166	May 1	...	...	...	4	3	...	...	...	...	...	....
Philadelphia	435	5	144	May 14	...	...	...	1	2	0	0	0	1	0	1
Watertown	737	16	152	May 7	...	2	2	1	4	1	3	0	1	2	....
ST. LAWRENCE															
Canton	448	17	144	May 7	...	...	2	4	3	3	3	0	0	1	1
North Hammond	420	19	154	May 8	...	3	3	1	0	4	1	2	4	1	....
Ogdensburg	175	17	154	May 6	1	2	2	1	3	0	3	1	3	1	....
Potsdam	430	16	143	May 10	...	...	1	3	2	3	3	1	2	1	....
WESTERN PLATEAU															
ALLEGANY															
Alfred	1,976	14	133	May 15	...	1	1	0	2	3	0	3	1	1	2
Angelica	1,340	21	125	May 23	...	...	...	...	1	4	3	3	2	3	5
Bolivar	1,800	15	110	May 27	...	...	1	0	0	1	1	1	4	2	5
CATTARAUGUS															
Allegany	1,421	5	135	May 11	...	...	...	...	3	0	0	1	1	...	....
Franklinville	1,598	14	128	May 22	...	...	...	1	1	1	3	1	1	2	4
Humphrey	1,950	13	136	May 14	...	...	1	2	0	2	1	1	4	2	....
Otto	1,410	9	144	May 8	...	1	1	0	3	1	1	0	1	0	1
CHEMUNG															
Elmira	863	17	158	April 29	4	2	2	1	2	1	2	0	3	...	....
STEUBEN															
Addison	1,000	21	154	May 8	1	2	1	2	3	2	3	3	3	1	....
Atlanta	1,200	7	131	May 17	...	...	...	1	0	1	0	1	2	2	....
South Canisteo	1,480	19	122	May 22	...	...	1	0	1	2	2	2	4	2	5
WYOMING															
Arcade	1,770	11	125	May 24	...	1	1	0	0	0	2	0	2	2	3

FIRST KILLING FROSTS IN FALL

	Elevation	Years record	Average length of season (days)	Average date of first frost	Number of years first frost occurred within 5-day periods, ending with date at head of column: September				October						November
					15 or before	16–20	21–25	26–30	1–5	6–10	11–15	16–20	21–25	26–31	1 or after
NORTHERN PLATEAU															
ESSEX															
Keene Valley	1,000	16	118	Sept. 18	8	2	2	1	2	0	0	1	...	...	....
Saranac Lake	1,620	14	114	Sept. 13	8	2	3	1	...	...	...	...	...	...	....
South Schroon	1,225	6	119	Sept. 16	3	1	2	...	...	...	...	...	...	...	....
FRANKLIN															
Gabriels	1,729	10	94	Sept. 7	8	1	0	0	0	1	...	...	...	...	....
Tupper Lake	1,552	9	107	Sept. 16	5	1	0	2	0	0	1	...	...	...	....
HAMILTON															
Indian Lake	1,705	11	84	Sept. 4	10	0	0	0	1	...	...	...	...	...	....
North Lake	1,822	11	122	Sept. 28	2	0	2	2	3	0	1	1	...	...	....
LEWIS															
Lowville	900	21	134	Sept. 26	4	4	3	4	2	1	1	1	1	...	....
Number Four	1,571	16	112	Sept. 11	3	4	6	1	0	1	1	...	...	...	....
ST. LAWRENCE VALLEY															
FRANKLIN															
Moira	200	12	142	Oct. 2	1	2	1	0	4	1	1	2	...	...	....
JEFFERSON															
Adams Center	540	11	146	Oct. 8	1	0	1	1	1	2	2	1	2	...	....
Cape Vincent	246	7	166	Oct. 14	...	...	...	...	...	3	1	1	2	...	....
Philadelphia	435	5	144	Oct. 5	1	0	0	0	1	1	1	1	...	...	....
Watertown	737	17	152	Oct. 6	1	0	2	0	4	3	1	3	0	3	....
ST. LAWRENCE															
Canton	448	17	144	Sept. 28	2	2	4	1	4	3	0	1	...	...	....
North Hammond	420	17	154	Oct. 9	2	0	1	0	1	7	1	3	1	0	1
Ogdensburg	175	19	154	Oct. 7	1	1	1	3	3	4	1	4	1	...	....
Potsdam	430	17	143	Sept. 30	2	0	4	3	3	2	2	1	...	...	....
WESTERN PLATEAU															
ALLEGANY															
Alfred	1,976	13	133	Sept. 25	3	0	3	3	3	1	...	...	...	...	....
Angelica	1,340	22	125	Sept. 25	6	1	4	5	2	2	1	0	0	1	....
Bolivar	1,800	13	110	Sept. 14	8	1	1	2	1	...	...	...	...	...	....
CATTARAUGUS															
Allegany	1,421	5	135	Sept. 23	1	1	0	1	0	1	1	...	...	...	....
Franklinville	1,598	14	128	Sept. 27	3	3	1	3	0	2	0	2	...	...	....
Humphrey	1,950	14	136	Sept. 27	3	0	2	4	3	1	1	...	...	...	....
Otto	1,410	8	144	Sept. 29	3	0	0	1	0	2	0	1	1	...	....
CHEMUNG															
Elmira	863	16	158	Oct. 3	1	1	3	1	2	5	2	0	0	1	....
STEUBEN															
Addison	1,000	22	154	Oct. 9	2	0	2	3	4	3	2	2	1	3	....
Atlanta	1,200	7	131	Sept. 25	2	1	1	1	1	1	...	...	...	...	....
South Canisteo	1,480	20	122	Sept. 21	6	3	4	4	2	0	1	...	...	...	....
WYOMING															
Arcade	1,770	11	125	Sept. 26	3	0	3	3	1	0	1	0	0	1	....

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